

Significant Incidents in Human Spaceflight

WHAT IS IT?

Human spaceflight grew out of the Cold War between the United States and the Soviet Union. Competitive struggles laid the groundwork with advances in high altitude flight, rocketry, and human performance. Human spaceflight reached its first defining success more than half a century ago, when Cosmonaut Yuri Gagarin became the first man to orbit the Earth in April 1961. In November 2000, a multi-national crew moved aboard the International Space Station. By November 2011, the former Cold War rivals had collaborated to surpass 10 years of continuous presence in space. Now a new record of continuous space habitation is established daily.

The Significant Incidents and Close Calls in Human Spaceflight chart presents a visual overview of major losses and close calls spanning the history of human spaceflight. It heightens awareness of the risks that must be managed as human spaceflight continues to advance.

HOW DOES IT WORK?

Events on the chart are organized by flight phase and ordered chronologically within each phase. Each event is represented by a small box which includes the mission name, date, a brief description of the incident and any significant result, such as injury or loss of life.

Three types of important events are highlighted: loss of crew, crew injury, and related or recurring events. Events with one or more crew fatalities are considered a loss of crew and highlighted in red. Crew injury or illness and/or loss of vehicle or mission is designated by orange shading. Related or recurring events are grouped together and set apart by yellow shaded boxes. These events have occurred repeatedly, are similar in nature, and may continue to occur today.

WHY DO WE HAVE IT?

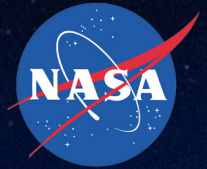
The Significant Incidents and Close Calls in Human Spaceflight chart is maintained by NASA Johnson Space Center's Flight Safety Office to raise awareness of lessons that have been learned through the years. It is a visible reminder of the risks inherent in human spaceflight. It is intended to spark an interest in past events, inspire people to delve into lessons learned, and encourage continued vigilance. It can aid in developing "what-if" scenarios and in ensuring the lessons of history are incorporated into new designs. It is being distributed as widely as possible in the hope that future accidents may be prevented.

WHAT IS THE BONDARENKO STORY?

Two fatal events, the Soviet altitude chamber oxygen fire and the Apollo 1 terminal countdown demonstration test, highlight the importance of sharing information. On March 23, 1961 Soviet cosmonaut Valentin Bondarenko lost his life after being severely burned in an altitude chamber fire. The incident occurred during a routine training exercise, when Bondarenko attempted to throw an alcohol swab into a waste basket, but hit the edge of a hot plate instead. The oxygen-rich environment quickly ignited. Rescue efforts were thwarted because internal pressure prevented rescuers from opening the chamber's inwardly swinging hatch for several minutes. By the time the pressure was released and the hatch could be opened, Bondarenko had been hopelessly burned. He died hours later.

Six years later, three U.S. astronaut's lives were lost in a fire during the terminal countdown demonstration test. During the test, the Apollo crew module contained an oxygen-rich atmosphere. An electrical short caused a fire that spread quickly throughout the cabin. Again, rescue efforts were delayed due to the buildup of pressure behind an inwardly opening hatch. Unlike the Soviet altitude chamber oxygen fire, the crew did not die due to burns from the fire, but from cardiac arrest caused by smoke inhalation. However, in both the Bondarenko tragedy and the Apollo 1 incident, high levels of oxygen caused the fires to spread rapidly, and pressure against inward opening hatches slowed rescue efforts. Neither cabin was equipped with effective fire-suppression equipment.

Information about the Bondarenko incident was not known in the U.S. until 1986 – more than 20 years later. Would access to this information have led to design changes that saved lives? Although that question can never be answered, these events underscore the importance of sharing information in the effort to prevent future tragedies.



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Legend

Loss of Crew	Crew Injury/Illness and/or Loss of Vehicle or Mission	Related or Recurring event
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STS-110 STS-109 STS-108	4/8/2002 3/1/2002 12/5/2001	Progress M-12M (44P) Anomaly in fuel pressurization system led to shutdown of 3 rd stage engine. Vehicle failed to reach orbit. Crew: 0 Loss of Vehicle/Mission
STS-91	6/2/1998	Main engine pressure chamber sensor failed. If it occurred later, logic error may have triggered a RTLS. Crew: 6
Soyuz TM-9	2/11/1990	DM insulation torn loose on ascent; contingency EVA repair. Crew: 2

SRB Seal Events (1981-1996)	
STS-51L (Challenger)	1/28/1986 Loss of Crew

Other SRB gas sealing anomalies: STS-2, 6, 41B, 41C, 41D, 51C, 51D, 51B, 51G, 51F, 51J, 61A, 61B, 61C, 42, 71, 70, 78

STS-51F	7/29/1985	Temperature sensor problems resulted in SSME shutdown at T+5:45. Crew: 7 Abort To Orbit
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Soyuz 18-1 (18a)	4/5/1975	Electrical fault caused premature firing of half of the 2 nd stage separation bolts, resulting in the inability to fire the remaining ones. Staging failure resulted in abort sequence being used at T+29.5 seconds. Crew: 2 Loss of Vehicle/Mission
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Apollo 13	4/11/1970	2 nd stage center engine shutdown due to pogo oscillations. Crew: 3
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Apollo 12	11/14/1969	Lightning strike on ascent. Crew: 3
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Gemini 10	7/18/1966	1 st stage oxidizer tank exploded at staging. No discernable effects. Nominal ascent. Crew: 2
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STS-112	10/7/2002	T-0 umbilical issues resulted in none of the system A pyrotechnic charges firing. Crew: 6
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STS-61C	1/6/1986	System configuration errors resulted in inadvertent drain back of 14,000 lbs of LOX prelaunch, which would have resulted in a Trans-Atlantic Abort Landing. Crew: 7
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<u>On-pad Abort Events (1984-1993)</u>	
STS-41D	6/26/1984
Following a pad abort, LH ₂ leaked from SSME3, resulting in a fire at the base of the orbiter.	
Crew: 6	

Soyuz T-10-1 (T-10a)	9/26/1983	Pad booster fire/explosion. Capsule Escape System used. Crew: 2 Loss of Vehicle/Mission
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Other On-pad Abort Events:	
STS-51F, STS-55, STS-51, STS-68,	

STS-1	4/12/1981	SRB ignition pressure wave caused TPS and structural damage. Crew: 2
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Apollo 1 (AS-204)	1/27/1967	Crew cabin fire (electrical short + high pressure O ₂ atmosphere). Crew: 3 Loss of Crew
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Gemini 6	12/12/1965	Main engine shutdown. Booster left unsecured on pad. Crew elected not to eject. Launched 3 days later. Crew: 2
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STS-117	6/8/2007	Thermal blanket damage. EVA performed to repair damage. Crew: 7
STS-114	5/26/2005	Bird strike on External Tank. Loss of foam from External Tank PAL ramp. TPS gap filers protruding. Removed during third mission EVA. Missing O-ring resulted in ejection of one of two NSIs, compromising the ET forward separation bolt function and damaging secondary structure and a thermal blanket. Crew: 7
STS-93	7/23/1999	At T+5 a short on AC1 Phase A resulted in loss of SSME1 Controller A and SSME3 Controller B. SSME3 H ₂ leak; early LOX depletion and shutdown. Crew: 5

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<ul style="list-style-type: none">• At T+5 a short on AC1 Phase A resulted in loss of SSME1 Controller A and SSME3 Controller B.• SSME3 H₂ leak: early LOX depletion and shutdown.	
Crew: 5	

STS-95	10/29/1998	Drag chute door separated during launch and impacted main engine bell. Crew: 7
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Other significant ascent debris events have occurred on:	
STS-116 and STS-125	

Late Release Orbiter Tyvek Covers	
STS-114, 115, 118, 119, 124, 126	

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	Crew: 1
	SpaceShipOne, 14P 5/1
	Flight computer unreprogrammed
	Recovered by rebooting

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EVA Incidents Summary (1965-2014)	
13 EVAs resulted in crew injury: Gemini 10, Apollo 17, Salyut 7 PE-1, Salyut 7 VE-3, STS-61-B EVAs 1&2, STS-37, Mir PE-9, STS-63, STS-97/4A, STS-100/6A EVAs 1&2, STS-134/ULF6	
See the Significant Incidents in EVA Operations Graphic for more details. (spaceflight.nasa.gov/outreach/readersroom.html)	

Ascent Debris		
STS-124	5/31/2008	Pad 39-A flame trench suffered significant damage causing about 3,500 refractory bricks to be blown away from the flame trench wall. Crew: 7

STS-95	10/29/1998	Drag chute door separated during launch and impacted main engine bell. Crew: 7
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bypassing faulty sensor. Crew: Soyuz 3, ISS 3	
ISS, Increment 17	4/3/99
Freon 218 leaked from SM AC. Crew: 3	

Soyuz T-10-1 (T-10a)	9/26/1983	Pad booster fire/explosion. Capsule Escape System used. Crew: 2 Loss of Vehicle/Mission
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Apollo 10	5/22/1969	Switch misconfiguration resulted in lunar module control problems. Crew: 2
Apollo 14	1/31/1971	Multiple failed docking attempts. Contingency procedures developed to mitigate risk of recurring docking anomaly. Docking successful. Crew: 3
Apollo 13	4/13/1970	Explosion due to electrical short. Loss of O ₂ and EPS. Crew: 3 Loss of Mission

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ISS, Flight 2A.1	5/1999	Crew sickened in FGB; likely a result of high localized CO ₂ levels due to poor ventilation.
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re - Soviet 3/23/1961	Navy Chamber

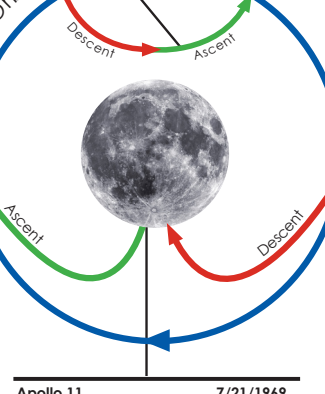
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ISS Increment 38	12/11/2013	ITCS configuration errors resulted in near freezing and potential rupture of water-to-ammonia heat exchanger. Crew: 6
ISS Increment 2	4/24/2001	Failure of all U.S. command and control computers on ISS. Crew: 10
STS-44	11/24/1991	Failure of IMU 2 caused MDF to be declared. 10-day mission shortened to 7 days. Crew: 6 Minimum Duration Flight
STS-99	2/2000	High bacterial count in postflight sample after GIRA installed to removed iodine. Crew: 6
Soyuz TMA-18 (22S)	9/23/2010	First attempt to separate from ISS failed; ISS crew succeeded in bypassing faulty sensor. Crew: Soyuz 3, ISS 3
ISS Increment 17	4/30/2008	Freon 218 leaked from SM A/C. Crew: 3
ISS Increment 15	6/10-6/18/2007	Power switch failures caused loss of ISS propulsive attitude control capability. Crew: 10
ISS Increment 13	8/2006	Trial coolant leak in SM. Crew: 3
ISS Increment 10	2/2005	Potential acid preservative aerosol escape from Russian urinal. Crew: 2
ISS Increment 5&6	mid-2002-2/03	Formaldehyde periodically exceeded long-term limits. Crew: 3-10
ISS Increment 2-4	4/2001-3/2002	Freon 218 leaked from SM A/C. Crew: 3
ISS Increment 4	2/2002	MetOx regeneration caused noxious air. Crew: 3
ISS	8/2001	Extremely high methanol levels in FGB air sample. Crew: 3
STS-104	7/2001	EMU battery leaked hazardous KOH. Discovered during EMU checkout. Crew: 5

STS-95	10/29/1998	Prelight sterilization process chemically altered the Low Iodine Residual System resulting in contaminated drinking water. Crew: 7
STS-87	11/21/1997	Spartan satellite deployed without proper activation. Recapture with RMS unsuccessful. Later captured by EVA crew. Crew: 6
STS-83	4/6/1997	Failure of fuel cell number 2 resulted in MDF being declared. The 15-day mission was shortened to 3 days. Crew: 7 Minimum Duration Flight
STS-51	9/12/1993	Both port-side primary and secondary SUPERZIP explosive cords fired, resulting in containment tube failure and damage in the payload bay. Crew: 5

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